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RESEARCH ARTICLE

Anticipating the value of share repurchase announcements: The role of short sellers

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Abstract

This study investigates whether short sellers anticipate undervaluation information before a repurchase announcement. Apart from exploring investment opportunities via searching for unfavourable information, short sellers should have the same incentive to identify favourable information to prevent potential losses. An observed significant negative relation between pre-announcement short selling activities and announcement abnormal returns supports the informed hypothesis. This negative relation is stronger under high levels of information asymmetry, and more significant when the repurchase announcement is associated with the undervaluation.

KEYWORDS

information asymmetry, informed trading, share repurchases, short selling, undervaluation

1 | INTRODUCTION

Managers make share repurchase announcements to signal undervaluation to the market, which subsequently leads to a price increase because of the value correction. However, firms also use repurchase programmes to distribute cash when they run out of good investment opportunities (Grullon & Michaely, 2004) or as part of a strategy to rebalance its capital structure (Dittmar, 2000). The value of a repurchase announcement signal differs according to the actual plan behind the scenes.

The objective of this study is to determine whether short sellers acquire private information prior to repurchase announcements to anticipate the value of the announcement. Short selling is a strategy in which traders sell stocks that they do not own when they believe that the stock will fall in price in the future when they are committed to buying the share. Short sellers have strong incentives to acquire information before unfavourable news to profit from a high selling price (Christophe, Ferri, & Angel, 2004; Christophe, Ferri, & Hsieh, 2010; Desai, Krishnamurthy, & Venkataraman, 2006; Henry, Kisgen, & Wu, 2015), while they should have the same incentive to anticipate favourable news to prevent potential losses due to a high buy-back price in the future. If firms announce a share repurchase to signal the stock's undervaluation, then potential price jumps following the signal would become the motive for short sellers to keep silence in their short selling activities to avoid losses.

The following empirical analysis investigates three hypotheses on short sellers' anticipation for share repurchase announcements. Hypothesis 1 states that if short sellers are informed traders, then the returns associated with repurchase announcements should be negatively associated with the level of short selling before the announcements. The higher the price jump following the repurchase announcement is, the greater the buying costs are for short sellers who short sell the stock in advance and buy it back in the future. Therefore, the value of the

repurchase announcement, measured by announcement abnormal returns, generates strong incentives to acquire private information to prevent potential losses. I conduct both a portfolio comparison and multivariate regression analysis and find an association between high announcement abnormal returns and with low pre-announcement short interest ratio (SIR), which suggests that short sellers are informed about the value of the announcement in advance.

The incentive to acquire information should be greater if the potential degree of mispricing is high. Firms with high levels of information asymmetry are more likely to be mispriced. Therefore, in my second hypothesis, I predict that the negative relation between SIR and abnormal announcement returns should be more significant under high levels of pre-announcement information asymmetry. I find a stronger negative relation for firms with high stock price volatility, low analyst coverage, or small size, which supports hypothesis 2.

Third, short sellers, who benefits from the depreciation of the share price, should have a strong incentive to detect undervalued stocks and try to avoid shorting those stocks. Therefore, if the repurchase announcement is associated with the value correction rationale, then the incentive to acquire ex ante private information should be greater. Consistent with this expectation, I observe a stronger negative relation between SIR and abnormal announcement returns when the repurchase announcement is more likely to be associated with undervaluation, proxied by high book-to-market (BM) ratios. I do not observe any significant increase in the negative relation when the repurchase announcement is more likely to be for other reasons, such as to distribute excess cash (proxied by high free cash flows), or to adjust the firm's leverage (proxied by low leverage ratios).

This paper contributes to the repurchase literatures that focus on the managerial value correction and signalling hypothesis. Managers use repurchases primarily to signal better prospects when the share is undervalued (Huang & Thakor, 2013; Stephens & Weisbach, 1998; Vermaelen, 1981). However, others argue that manager could initiate a repurchase programme to meet other objectives. For example, Grullon and Ikenberry (2000), Grullon and Michaely (2004), and Brav, Graham, Harvey, and Michaely (2005) show that firms recently favour repurchases as a method to pay shareholders as it is more flexible and tax efficient than dividends are. Dittmar (2000) and Hovakimian, Opler, and Titman (2001) find that firms also buy-back shares to increase their leverage ratios. My study shows that sophisticated market participants, such as short sellers, have incentives to determine the motive behind a repurchase announcement to prevent losses following the signalling effects.

Apart from the repurchase literature, my study also contributes to the literature on short selling. Existing studies show evidence that short sellers hold superior information, but mainly concentrate on unfavourable events, such as downside earnings surprises (Christophe et al., 2004), earnings restatements (Desai et al., 2006), financial misconduct (Karpoff & Lou, 2010), analyst downgrades (Christophe et al., 2010), stock crashes (Callen & Fang, 2015), and bond rating downgrades (Henry et al., 2015). My study adds to this literature by showing that short sellers can even anticipate favourable news as they have an incentive to prevent potential losses.

The remainder of this paper proceeds as follows: I develop the hypotheses in Section 2 and describe the data and methodologies in Section 3. I report the empirical results in Section 4 and conclude in Section 5.

2 | BACKGROUND AND HYPOTHESES

Short selling is generally motived by high profits following price depreciations. In short selling, traders borrow stocks and sell them at a high price and buy them back at a low price. Theoretical models (Diamond & Verrecchia, 1987) suggest that short sellers normally have access to private information as shorting involves higher transaction costs than does purchasing shares or selling shares the trader already own. Empirical studies show that, short sellers often show their ability to identify low future returns (Asquith, Pathak, & Ritter, 2005; Boehmer, Jones, & Zhang, 2008; Desai, Ramesh, Ramu Thiagarajan, & Balachandran, 2002) or downward stock price movements following unfavourable news (Christophe et al., 2004; Christophe et al., 2010; Desai et al., 2006; Henry et al., 2015; Karpoff & Lou, 2010). However, there is little discussion of short selling activities corresponding to favourable news.[1]

The potential for unlimited losses from price appreciations would increase short sellers' incentive to acquire private information to anticipate favourable news. An undervaluation signal from the firm itself, like a repurchase announcement, is clearly an event that short sellers should avoid. Anticipating the value of a repurchase announcement, which firms often use to signal undervaluation (Babenko, Tserlukevich, & Vedrashko, 2012; Huang & Thakor, 2013; Stephens & Weisbach, 1998), saves short sellers from potential losses. The higher the price jump following the undervaluation signal, the greater the losses short sellers will

suffer if they are in a short position before the announcement. Therefore, if short sellers are informed of this favourable information, then short selling activities should stay at a low level when the potential price jump following the repurchase announcement will be high.

Hypothesis 1 *The returns associated with repurchase announcements should be negatively associated with the level of short selling before the announcements.*

If hypothesis 1 is true, then short sellers do pay attention to favourable information to avoid potential losses caused by a correction of mispricing. The greater the information asymmetry is, the more likely it is that the stock is mispriced. Therefore, I expect short sellers to have a stronger incentive to acquire private information under high levels of information asymmetry.

Hypothesis 2 *The negative relation between pre-announcement short selling activities and abnormal announcement returns is stronger under high levels of pre-announcement information asymmetry.*

Not all repurchase announcement aims to signal undervaluation. Firms can initiate repurchases to distribute excess capital or optimize the capital structure (Dittmar, 2000; Grullon & Michaely, 2004). The incentive to acquire private information should be stronger if the announcement is more likely to be motivated by the objective of correcting undervaluation.

Hypothesis 3 *The negative relation between pre-announcement short selling activities and abnormal announcement returns is more significant if the firm makes a repurchase announcement for undervaluation reasons.*

3 | DATA AND METHODOLOGY

I collected the sample of open-market share repurchase announcements between 1980 and 2016 from the Thomson Financial Securities Data Company's (SDC) database. I keep only the first announcement if there are multiple repurchase announcements released within the same month. I compiled the short selling data from the COMPUSTAT Supplemental Short Interest File. Consistent with prior studies (Callen & Fang, 2015; Desai et al., 2006; Kot, 2007), I measure the SIR as the number of shares shorted on the 15th business day of each month[2] scaled by number of shares outstanding. I obtained the firm-level accounting data from the COMPUSTAT annual files and analyst forecasts data from I/B/E/S. The final sample consists of 17,437 observations.

I measure the value of the repurchase announcement using 3-day abnormal announcement returns, buy-and-hold abnormal returns BHAR(−1, +1). I also include the long-term market reactions, measured by BHAR(+2, +252), to consider potential post-announcement drifts 1 year after the announcement (Ikenberry, Lakonishok, & Vermaelen, 1995). Piling up daily returns over a long-term period may potentially cause measurement biases (Kothari & Warner, 1997). Hence, apart from using daily returns, I also use monthly returns to calculate the ex post 1-year BHARs. Following Barber and Lyon (1997), I employ the control firm approach to correct the misspecification of the tests for detecting long-term abnormal returns. I calculate the BHARs following the market-adjusted model in which I use Fama–French 5 × 5 size and BM portfolios as benchmark portfolios.[3] I match the sample firms to an appropriate size portfolio for the preceding first of July based on their market value of equity (closing price per share multiplied by the number of shares outstanding) 1 month before the announcement. I then match the sample firms to an appropriate BM portfolio for the preceding first of July based on their BM ratios, which I calculate as book value of equity (COMPUSTAT Data Item 60) in year t-1 corresponding to the announcement divided by the market value of equity 1 month before the announcement. I exclude firms with a negative book value of equity.

As an alternative method to calculate abnormal announcement returns, I use cumulative abnormal returns CAR(−1, +1), which I calculate following the market model in which the estimated parameters are based on the CRSP value-weighted index with an estimation window of (−252, −44). I sourced the daily return data from the CRSP daily stock file.

To test the relation between SIR and the value of the repurchase announcement, I first conduct a portfolio comparison. I sort all sample firms into low, median, high groups based on the pre-announcement short selling activities (the SIR 1 month before the repurchase announcement, and the average SIR over the last 3 months before the repurchase announcement, respectively). I then compare the announcement abnormal returns between the low and high SIR (or avg_SIR) groups to investigate whether short sellers can anticipate the value of the repurchase announcements.

To control firm-level characteristics, I further test the relation between pre-announcement short selling activities and the value of the announcement by estimating the following multi-variable regression:

$$BHAR_i = \alpha_0 + \alpha_1 SIR_i + \alpha_2 Controls_i + \varepsilon_i \quad (1)$$

where *BHAR* is the buy-and-hold abnormal returns during the three-day (−1, +1) event window. *SIR* is the short interest ratio 1 month before the announcement. *Controls* contains a set of common control variables from previous studies (Babenko et al., 2012; Gong, Louis, & Sun, 2008) showing that they have explanatory power for the market performance associated with repurchase announcements. The set of control variables includes stock price runup, repurchase size, cash, firm size, analyst coverage, price volatility, free cash flow, leverage, and Tobin's Q. I measure stock price runup by pre-announcement abnormal returns, BHAR(−43, −4). Repurchase size is to the proposed value of the transaction normalized by the market value of equity. Cash is the latest cash and equivalents (COMPUSTAT Data Item 1) scaled by total assets (COMPUSTAT Data Item 6) prior to the announcement. Firm size is the market value of equity 1 month prior to the announcement. Analyst coverage is the number of analyst forecasts 1 month prior to the announcement scaled by 1,000. Price volatility is the standard deviation of the stock's returns over the year prior to the announcement. Free cash flow is the latest operating income before depreciation (COMPUSTAT Data Item 13) scaled by total assets prior to the announcement. Leverage is the latest ratio of debt to market value of equity prior to the announcement, where debt equals the debt in current liabilities (COMPUSTAT Data Item 34) plus long-term debt (COMPUSTAT Data Item 142). Tobin's Q is proxied by the latest BM ratio prior to the announcement. Table 1 provides a statistical summary of the explanatory variables.

I control for industry using industry dummies based on the Fama and French 12 industry classification. I sort stocks into 12 industry categories based on the four-digit Standard Industrial Classification (SIC) codes provided by CRSP. I also include year dummies to control for time variations.

I further replace the dependent variable BHAR(−1, +1) with CAR(−1, +1) to provide an alternative

TABLE 1 Statistic summary of main variables

	N	Mean	Median	5th	95th	*SD*
SIR	17,437	2.17%	0.35%	0.00%	10.15%	0.0425
avg_SIR	17,437	2.14%	0.38%	0.00%	9.96%	0.0412
BHAR(−1, +1)	17,437	2.11%	1.42%	−7.49%	13.84%	0.0791
CAR(−1, +1)	17,437	2.10%	1.44%	−7.71%	13.79%	0.0799
BHAR(+2, +252)	17,437	4.02%	−1.07%	−57.09%	75.65%	0.5535
CAR(−43, −4)	17,437	−5.08%	−3.41%	−35.97%	19.46%	0.1845
BHAR(−43, −4)	17,437	−4.26%	−3.36%	−29.95%	17.45%	0.1583
Repurchase size	17,437	0.0804	0.0597	0.0173	0.2461	0.0587
Cash	17,437	0.1495	0.0819	0.0061	0.5509	0.1590
Firm size	17,437	6.1651	6.0483	2.9181	9.9055	2.0070
Analyst coverage	17,437	7	4	0	24	7.9650
Price volatility	17,437	0.1006	0.0879	0.0381	0.2238	0.0504
Free cash flow	17,437	0.1228	0.1197	0.0081	0.2961	0.0856
Leverage	17,437	0.4642	0.1997	0.0000	2.3196	0.6307
Tobin's Q	17,437	0.6510	0.5675	0.1391	1.5766	0.3932

Note: This table reports the statistic summary of main variables. SIR is the number of share shorted normalized by number of shares outstanding 1 month prior to the repurchase announcements. Avg_SIR is the average SIR 3 months prior to the repurchase announcements. BHARs are calculated following the market-adjusted model with Fama and French 5*5 size and BM benchmark portfolios. CARs are calculated following the market model with CRSP value-weighted index. Repurchase size the proposed value of transaction normalized by the market value of equity. Cash is the latest cash and equivalents scaled by the total assets. Firm size is the market value of equity. Analyst coverage is the number of analyst forecasts. Price volatility is the standard deviation of stocks returns over the previous year of the announcements. Free cash flow is the operating income before depreciation scaled by the total assets. Leverage is the ratio of debt to market value of equity, where debt equals to debt in current liabilities plus long-term debt. Tobin's Q is proxied by the book-to-market ratio.

estimation of abnormal returns, and using BHAR(+2, +252) and ex post 1-year BHARs to capture the long-term residuals following the immediate reaction. I further run regressions on avg_SIR, which is the average SIR over the last 3 months corresponding to the announcement, instead of regressing on SIR with a one-month lag as a robustness check.

4 | EMPIRICAL RESULTS

In this section, I first explore whether short sellers anticipate the value of repurchase announcements by investigating the relation between SIR and announcement returns. I then investigate whether this relation is affected by the level of information asymmetry because the incentive to acquire private information is stronger for firms with a high potential of mispricing. Finally, I discuss whether short sellers can detect the possible reasons behind the repurchase announcement, which will subsequently affect the relationship between the SIR and announcement returns.

4.1 | Relation between short selling and the value of repurchase announcements

I argued in the Introduction that short sellers have an incentive to acquire information to prevent losses. An implication of this argument is that the SIR is negatively correlated with announcement abnormal returns. To test this prediction, I first sort all sample firms into low, median, and high groups based on the SIR or average SIR, respectively. I then calculate the buy-and-hold abnormal returns over day −1 and + 1 corresponding to the repurchase announcement, and compare the announcement return across SIR groups. My main results are based on BHAR(−1, +1), while I report further results based on CAR(−1, +1) as an alternative approach, as well as BHAR(+2, +252) and ex post 1-year BHARs to incorporate long-term announcement drifts.

Table 2 shows the results of portfolio comparison across low to high SIR groups. In general, the average announcements returns are significantly positive among all SIR groups, which suggests that repurchase announcements send out favourable news in average. Specifically, there is a significant increase in announcement returns as we move from the high to low SIR groups. The comparison of the announcement returns for high and low SIR groups is significant and consistent across all measurements of announcement value. By extending the pre-announcement observation period of short selling interest up to three months before the repurchase announcement, the results are unchanged.

The regression results reported in Table 3 present a similar picture with the controls for firm characteristics. The estimated coefficient in the regression of

TABLE 2 Portfolio comparison across SIR groups

Panel A: Abnormal returns across SIR groups				
	BHAR(−1, +1)	**CAR(−1, +1)**	**BHAR(+2, +252)**	**Ex post 1-year BHAR (monthly)**
P1 (low)	3.19%***	3.20%***	6.53%***	6.03%***
P2	1.64%***	1.63%***	2.25%***	1.60%***
P3 (high)	1.38%***	1.35%***	2.98%***	2.33%***
P3-P1	−1.81%***	−1.86%***	−3.55%***	−3.70%***
Panel B: Abnormal returns across avg_SIR groups				
	BHAR(−1, +1)	**CAR(−1, +1)**	**BHAR(+2, +252)**	**Ex post 1-year BHAR (monthly)**
P1 (low)	3.19%***	3.22%***	6.74%***	6.21%***
P2	1.64%***	1.63%***	2.15%***	1.60%***
P3 (high)	1.43%***	1.39%***	2.99%***	2.29%***
P3-P1	−1.77%***	−1.82%***	−3.76%***	−3.92%***

Note: This table reports the portfolio comparison of the value of announcement returns across SIR group. All sample firms are sorted into low, median, high groups based on the pre-announcement short interest ratio, SIR and avg_SIR, respectively. SIR is the number of share shorted normalized by number of shares outstanding 1 month prior to the repurchase announcements. Avg_SIR is the average SIR 3 months prior to the repurchase announcements. BHARs are calculated following the market-adjusted model with Fama and French 5*5 size and BM benchmark portfolios. CARs are calculated following the market model with CRSP value-weighted index. Daily returns are used for calculating CARs and BHARs among the first three columns. Monthly returns are used for calculating ex post 1-year BHAR following the repurchase announcement in the last column. Conventional t-statistics are applied with significance levels of 10%, 5% and 1%, which are represented by *, **, and ***, respectively.

TABLE 3 Regression results on SIR

	BHAR(−1, +1)		CAR(−1, +1)		BHAR(+2, +252)		Ex post 1-year BHAR (monthly)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SIR	−0.076***		−0.072***		−0.215**		−0.234**	
	(−4.151)		(−3.847)		(−2.089)		(−2.246)	
Avg_SIR		−0.074***		−0.071***		−0.175*		−0.187*
		(−3.979)		(−3.789)		(−1.649)		(−1.715)
Stock price runup	−0.054***	−0.054***	−0.020***	−0.020***	0.059	0.059	0.096**	0.097**
	(−8.637)	(−8.641)	(−3.242)	(−3.249)	(1.228)	(1.236)	(2.008)	(2.020)
Repurchase size	0.104***	0.104***	0.104***	0.104***	0.283***	0.281***	0.292***	0.290***
	(8.448)	(8.441)	(8.396)	(8.393)	(2.894)	(2.879)	(3.058)	(3.039)
Cash	−0.003	−0.003	0.000	0.000	0.029	0.029	0.037	0.037
	(−0.571)	(−0.577)	(0.082)	(0.078)	(0.669)	(0.656)	(0.887)	(0.872)
Firm size	−0.004***	−0.004***	−0.004***	−0.004***	0.000	0.000	0.000	0.000
	(−8.472)	(−8.482)	(−9.271)	(−9.270)	(−0.084)	(−0.109)	(0.130)	(0.100)
Analyst coverage	0.230***	0.230***	0.348***	0.347***	0.970	0.974	1.107*	1.113*
	(2.642)	(2.643)	(3.931)	(3.931)	(1.586)	(1.594)	(1.805)	(1.814)
Price volatility	0.122***	0.121***	0.122***	0.121***	0.760***	0.755***	0.820***	0.814***
	(6.437)	(6.416)	(6.379)	(6.358)	(5.051)	(5.016)	(5.494)	(5.451)
Free cash flow	−0.035***	−0.035***	−0.031***	−0.031***	0.187**	0.185**	0.131	0.129
	(−2.919)	(−2.941)	(−2.618)	(−2.638)	(2.313)	(2.288)	(1.590)	(1.563)
Leverage	−0.002*	−0.002*	−0.002	−0.002	0.011	0.011	0.011	0.011
	(−1.796)	(−1.809)	(−1.444)	(−1.454)	(1.156)	(1.139)	(1.189)	(1.170)
Tobin's Q	0.012***	0.012***	0.018***	0.018***	0.029	0.029*	0.023	0.024
	(4.285)	(4.299)	(6.627)	(6.636)	(1.637)	(1.655)	(1.401)	(1.424)
Constant	−0.041	−0.041	−0.038	−0.038	−0.260***	−0.258***	−0.305***	−0.303***
	(−1.504)	(−1.502)	(−1.416)	(−1.414)	(−3.263)	(−3.244)	(−4.051)	(−4.031)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-sq	0.053	0.053	0.052	0.052	0.013	0.013	0.013	0.013
Observation	17,437	17,437	17,437	17,437	17,437	17,437	17,404	17,404

Note: This table reports the results of regressing the value of repurchase announcement, measured by *BHAR(−1, +1)*, *CAR(−1, +1)*, *BHAR (+2, +252)*, or *ex post 1-year BHAR (monthly)*, on *SIR* or *avg_SIR* and other control variables. *SIR* is the number of share shorted normalized by number of shares outstanding 1 month prior to the repurchase announcements. *Avg_SIR* is the average SIR 3 months prior to the repurchase announcements. BHARs are calculated following the market-adjusted model with Fama and French 5*5 size and BM benchmark portfolios. CARs are calculated following the market model with CRSP value-weighted index. Daily returns are used for calculating CARs and BHARs in Columns (1)–(6). Monthly returns are used for calculating ex post 1-year BHAR following the repurchase announcement in Columns (7)–(8). Stock price runup is measured by *BHAR(−43, −4)* in Columns (1)–(2) and (5)–(8), and measured by *CAR(−43, −4)* in Columns (3)–(4). The variable of analyst coverage is scaled by 1,000. The reported t-statistics in brackets are based on the heteroskedasticity-consistent standard errors adjusted for clustering at the firm level.

BHAR(−1, +1) on SIR is negative and statistically significant. This negative relation is not sensitive to the choice of estimation approach by replacing dependent variable, BHAR(−1, +1), with CAR(−1, +1). Apart from short sellers' anticipation of short-term announcement value, I further find that the negative relation between pre-announcement short selling interest and the long-term value of repurchase announcements holds up to 1 year after the announcements. Again, the results are not sensitive to the number of pre-announcement observation months of short interest.

TABLE 4 Robustness checks

	Non-repurchase	Rep VS non-rep	Positive ARs	Negative ARs	Excl. Other news
	(1)	(2)	(3)	(4)	(5)
SIR	0.001	0.001	−0.038**	−0.078***	−0.067***
	(0.321)	(0.755)	(−2.262)	(−3.127)	(−3.592)
Stock price runup	−0.002***	−0.003***	−0.060***	0.019***	−0.054***
	(−4.144)	(−5.866)	(−9.298)	(2.765)	(−8.287)
Repurchase size			0.104***	−0.019	0.107***
			(8.141)	(−1.406)	(8.425)
Cash	0.002***	0.002***	0.018***	−0.021***	−0.003
	(4.405)	(4.634)	(2.970)	(−3.095)	(−0.522)
Firm size	0.000	0.000	−0.006***	0.003***	−0.004***
	(0.847)	(−1.502)	(−11.810)	(5.276)	(−8.464)
Analyst coverage	0.006	0.007	0.341***	−0.174	0.288***
	(0.718)	(0.883)	(4.091)	(−1.568)	(3.269)
Price volatility	−0.003	−0.001	0.270***	−0.174***	0.130***
	(−1.593)	(−0.574)	(14.038)	(−8.010)	(6.778)
Free cash flow	0.005***	0.006***	−0.034***	−0.009	−0.033***
	(6.037)	(6.514)	(−2.710)	(−0.629)	(−2.645)
Leverage	0.000	0.000	−0.001	−0.001	−0.002*
	(0.985)	(0.299)	(−0.603)	(−0.910)	(−1.925)
Tobin's Q	0.000	0.000**	0.008***	0.009***	0.012***
	(1.036)	(2.147)	(2.605)	(3.255)	(4.384)
Constant	−0.003***	−0.002***	0.044***	−0.039***	−0.048*
	(−3.164)	(−3.316)	(5.296)	(−3.315)	(−1.782)
SIR*with_rep		**−0.091*** **			
		(−5.754)			
with_rep		0.023***			
		(31.519)			
Industry dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Adj. R-sq	0.001	0.003	0.183	0.106	0.057
Observation	916,958	934,395	11,393	6,044	16,377

Note: This table reports the results of robustness checks for hypothesis 1 by regressing *BHAR(−1, +1)* on *SIR* and other control variables under different settings. *SIR* is the number of share shorted normalized by number of shares outstanding 1 month prior to the repurchase announcements. BHARs are calculated following the market-adjusted model with Fama and French 5*5 size and BM benchmark portfolios. Stock price runup is measured by *BHAR(−43, −4)*. Column (1) presents the regression results during non-repurchase period, while Column (2) presents the dif-in-dif regression results by incorporating an interactive dummy variable, *SIR*with_rep*, measured by *SIR* times *with_rep*. The variable, *with_rep*, equals 1 if there is a repurchase announcement in month t, and equals 0 otherwise. Column (3) and (4) presents the sub-sample results among positive and negative announcement returns, respectively. Column (5) presents the regression results for a non-other public news sample (excluding changes of analyst recommendation). The reported t-statistics in brackets are based on the heteroskedasticity-consistent standard errors adjusted for clustering at the firm level.

I also conduct a set of robustness checks. First, I run a difference-in-difference test to confirm that the negative relation between SIR and announcement return[4] is due to short sellers' expectations of repurchase announcements. The results in Column (1) of Table 4 show that the negative relation does not exist in periods isolated from the repurchase announcement, as the estimated coefficient of SIR is insignificant for the non-

repurchase sample. I further incorporate an interaction dummy between SIR and with_rep (equals to 1 if there is a repurchase announcement in month t or 0 otherwise). As Column (2) of Table 4 shows, the negative relation between SIR and announcement returns during repurchase announcement periods is statistically more negative than during non-repurchase announcement periods. This further confirms that the negative relation is driven by the anticipation of repurchase announcements.

Second, the observed negative relation between SIR and announcement returns may potentially reflect two scenarios: 1) a low SIR and high announcement returns, where the repurchase announcement contains favourable news; 2) a high SIR and low announcement returns, where the repurchase announcement contains unfavourable news, such as lack of investment opportunities. To ensure that the negative relation does not exist for only the favourable or unfavourable news scenarios, I provide a robustness check by separating the sample into two sub-samples based on the sign of announcement returns, positive BHAR(−1, +1) and negative BHAR (−1, +1). In Columns (3) and (4) of Table 4, the estimated coefficient of SIR on returns is significantly negative in both the positive returns and negative returns groups, respectively. This result suggests that short sellers can anticipate the value of repurchase announcements whether the news is favourable or unfavourable.

Third, I re-run the tests by excluding confounding news to ensure that the negative relation is not driven by other public news released during the same month as the repurchase announcement. I use changes in analyst recommendations as a proxy for other public news.[5] I exclude observation from the original sample if there is an analyst downgrade or upgrade in the same month as the repurchase announcement. The results in Column (5) of Table 4 show that the observed negative relation between SIR and announcement returns in the original sample still hold after excluding other public news. This enhances the argument of the informed trading hypothesis.

4.2 | The impact of information asymmetry

Firms with higher information asymmetry are more likely to be mispriced. Short sellers, who should be better informed, should have a stronger incentive to acquire private information in the case of high levels of information asymmetry to benefit from pre-announcement non-public information. I incorporate an interactive dummy variable, SIR*High Asym, to assess whether the negative relation between SIR and announcement returns is more significant under high levels of information asymmetry.

Table 5 shows the sensitivity tests results for the impact of information asymmetry, in which I use three proxies (price volatility, analyst coverage, and firm size) of information asymmetry. I use price volatility given Krishnaswami and Subramaniam's (1999) finding that higher volatility reflects higher information asymmetry. Consistent with my expectation, Column (1) of Table 5 shows that the negative relation between SIR and announcement returns is more significant among high volatility firms. Hong, Lim, and Stein (2000) suggest that the more analysts following a firm, the more information is delivered to the market. My results in Column (3) show a stronger negative SIR and announcement return relation among firms with low analyst coverage. Firm size is also a common measurement of information asymmetry (Llorente, Michaely, Saar, & Wang, 2002; Zhang, 2006), where larger firms are more likely to be transparent as they attract greater market attention. Again, I observe a greater negative coefficient on SIR among small firms in Column (5).

It is worth noting that smaller firms or firms with low analyst coverage are harder to short due to the availability of lendable shares. High volatility firms might also be harder to short over time. Therefore, high information asymmetry firms are likely to have a lower level of SIR and possibility a less responsive SIR to news. To mitigate the associated low SIR problem among high information asymmetry firms, I demean the SIR by using the past five-year average SIR for the firm. The regression results in Columns (2), (4), and (6) of Table 5, in which I replace SIR with the demeaned SIR to control for differences in the equity lending market conditions, show a similar picture as the previous results. The negative relation is still more significant among high information asymmetry firms.

4.3 | The impact of possible repurchase motives

Managers use repurchase announcements to signal that the firm's stock is undervalued. However, not all repurchase announcements correlate to this motivation. For example, Grullon and Michaely (2004) show that firms may use repurchase programmes as a channel to distribute excess cash. Dittmar (2000) finds that firms repurchase stocks to alter their leverage ratios. Short sellers should have a stronger incentive to anticipate the announcement information in advance if the repurchase is related to undervaluation, as the subsequent price correction may lead to great losses for

short sellers. Therefore, I expect a stronger negative relation between short selling interest and announcement return if the repurchase announcement is related to undervaluation or a less significant relation if the announcement is related to reasons besides undervaluation.

I use three variables (BM ratio, cash flow, and leverage ratio) to proxy the potential motives behind the repurchase announcements. Firms with a high BM ratio are more likely to be undervalued, high cash flow firms are more likely to use repurchases to distribute cash (for non-undervaluation purposes), and low leverage firms

TABLE 5 Sensitivities tests for the level of information asymmetry

	Price volatility		Analyst coverage		Firm size	
	(1)	(2)	(3)	(4)	(5)	(6)
SIR	−0.041**		−0.036**		−0.031*	
	(−2.110)		(−2.057)		(−1.881)	
SIR*high Asym	−0.104***		−0.121***		−0.122**	
	(−3.585)		(−3.372)		(−2.035)	
Demean SIR		−0.040*		−0.045**		−0.044**
		(−1.839)		(−2.272)		(−2.376)
Demean SIR*high Asym		−0.100***		−0.085*		−0.124*
		(−2.684)		(−1.896)		(−1.824)
High Asym	0.018***	0.014***	0.011***	0.005***	0.020***	0.011***
	(10.287)	(7.020)	(7.943)	(3.319)	(11.802)	(5.297)
Stock price runup	−0.059***	−0.036***	−0.065***	−0.040***	−0.063***	−0.040***
	(−11.833)	(−6.159)	(−13.108)	(−6.870)	(−12.636)	(−6.750)
Repurchase size	0.103***	0.069***	0.103***	0.070***	0.104***	0.073***
	(9.751)	(6.284)	(9.723)	(6.369)	(9.867)	(6.600)
Cash	0.003	0.003	0.010**	0.007	0.008*	0.006
	(0.776)	(0.634)	(2.274)	(1.391)	(1.740)	(1.182)
Free cash flow	−0.039***	−0.004	−0.042***	−0.006	−0.040***	−0.003
	(−4.183)	(−0.327)	(−4.473)	(−0.519)	(−4.323)	(−0.271)
Leverage	−0.003**	−0.001	−0.002**	−0.001	−0.002*	−0.001
	(−2.202)	(−1.008)	(−2.008)	(−0.818)	(−1.941)	(−0.624)
Tobin's Q	0.020***	0.013***	0.017***	0.012***	0.012***	0.010***
	(10.457)	(5.718)	(8.778)	(5.134)	(6.309)	(4.240)
Constant	−0.063**	−0.015	−0.060*	−0.012	−0.059*	−0.008
	(−1.973)	(−0.346)	(−1.875)	(−0.272)	(−1.848)	(−0.179)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-sq	0.048	0.029	0.046	0.025	0.050	0.027
Observation	17,437	9,138	17,437	9,138	17,437	9,138

Note: This table reports the results of regressing BHAR(−1, +1) on *SIR* and other control variables across different levels of information asymmetry. Price volatility, analyst coverage, and firm size are used as proxies of information asymmetry. *High Asym* equals to 1 if the level of information asymmetry is high (price volatility among the highest volatility quintile, the number of analysts following is less than two, or firm size among the smallest size quintile), and 0 otherwise. *SIR* is the number of share shorted normalized by number of shares outstanding 1 month prior to the repurchase announcements. *SIR*High Asym* is an interactive dummy variable measured by *SIR* times *High Asym*. *Demean SIR* is a demeaned *SIR* calculated by *SIR* minus a long-run average SIR over the past 5 years. *Demean SIR*High Asym* is an interactive dummy variable measured by *Demean SIR* times *High Asym*. BHARs are calculated following the market-adjusted model with Fama and French 5*5 size and BM benchmark portfolios. Stock price runup is measured by BHAR(−43, −4). The reported t-statistics in brackets are based on the heteroskedasticity-consistent standard errors adjusted for clustering at the firm level.

TABLE 6 Sensitivities tests for the motivations of repurchases

	BM ratio		Cash flow		Leverage	
	(1)	(2)	(3)	(4)	(5)	(6)
SIR	−0.072***		−0.098***		−0.078***	
	(−4.328)		(−5.010)		(−4.256)	
SIR*(Non-)Under	−0.088**		0.032		−0.033	
	(−2.125)		(1.100)		(−1.079)	
Demean SIR		−0.067***		−0.096***		−0.082***
		(−3.459)		(−4.216)		(−3.950)
Demean SIR*(Non-)Under		−0.104**		0.030		−0.013
		(−2.135)		(0.853)		(−0.339)
(Non-)Under	0.010***	0.006***	−0.005***	−0.001	−0.002	0.002
	(5.762)	(3.117)	(−2.683)	(−0.690)	(−1.159)	(1.123)
Stock price runup	−0.055***	−0.035***	−0.056***	−0.036***	−0.056***	−0.036***
	(−11.065)	(−5.929)	(−11.250)	(−6.111)	(−11.212)	(−6.105)
Repurchase size	0.109***	0.074***	0.116***	0.079***	0.117***	0.079***
	(10.508)	(6.825)	(11.320)	(7.335)	(11.368)	(7.398)
Cash	−0.004	−0.002	−0.004	−0.003	−0.002	−0.006
	(−0.945)	(−0.417)	(−1.013)	(−0.646)	(−0.397)	(−1.062)
Firm size	−0.005***	−0.002***	−0.005***	−0.003***	−0.006***	−0.003***
	(−9.787)	(−4.707)	(−11.623)	(−5.771)	(−12.137)	(−5.690)
Analyst coverage	0.216**	0.068	0.256**	0.085	0.258**	0.080
	(2.060)	(0.707)	(2.450)	(0.878)	(2.467)	(0.823)
Price volatility	0.119***	0.092***	0.115***	0.091***	0.115***	0.092***
	(7.914)	(5.034)	(7.675)	(4.990)	(7.670)	(5.025)
Constant	−0.036	0.004	−0.035	0.010	−0.033	0.009
	(−1.123)	(0.099)	(−1.080)	(0.236)	(−1.021)	(0.214)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-sq	0.052	0.032	0.050	0.030	0.050	0.030
Observation	17,437	9,138	17,437	9,138	17,437	9,138

Note: This table reports the results of regressing BHAR(−1, +1) on *SIR* and other control variables across groups with either undervaluation related or non-undervaluation related repurchase motives. Book-to-market (BM) ratio, leverage ratio, and cash flows are used to measure the likelihood of (non-)undervaluation. *Under* equals to 1 if the repurchase announcement is more likely to be linked with undervaluation reason (BM ratio among the highest quintile), or 0 otherwise. *Non-Under* equals to 1 if the repurchase announcement is more likely to be linked with non-undervaluation reason (cash flow among the highest quintile or leverage ratio among the lowest quintile), or 0 otherwise. *SIR* is the number of share shorted normalized by number of shares outstanding 1 month prior to the repurchase announcements. *SIR*(Non-) Under* is an interactive dummy variable measured by *SIR* times *(Non-)Under*. *Demean SIR* is a demeaned *SIR* calculated by *SIR* minus a long-run average SIR over the past 5 years. *Demean SIR*(Non-)Under* is an interactive dummy variable measured by *Demean SIR* times *(Non-)Under*. BHARs are calculated following the market-adjusted model with Fama and French 5*5 size and BM benchmark portfolios. Stock price runup is measured by BHAR(−43, −4). The reported t-statistics in brackets are based on the heteroskedasticity-consistent standard errors adjusted for clustering at the firm level.

are more likely to use repurchases to rebalance their capital structures (for non-undervaluation purposes). I then add an interaction dummy SIR*Under (or non-Under) in the regression to assess the sensitivity of the SIR to announcement returns across these repurchase motives. Consistent with my expectation, the estimated coefficient on the SIR in Column (1) of Table 6 is more negative among the high BM ratio firms, whose repurchase announcements are more likely to be linked with signalling undervaluation. There is no

such significant difference in the negative SIR and announcement returns relation among high cash flow firms (or low leverage firms), whose repurchase announcements are more likely to be linked with non-undervaluation purposes. The results are similar if I use the demeaned SIR.

5 | CONCLUSION

This study provides evidence that short sellers avoid targeting firms with favourable news. The significant negative relation between pre-announcement short selling interest and announcement returns suggests that short sellers anticipate the value of repurchase announcements in advance in order to prevent potential losses. This negative relation is stronger among firms that are more likely to be mispriced and more significant among firms that make repurchase announcements to signal undervaluation.

My findings suggest that silent short selling could add credibility to the repurchase announcements made to signal undervaluation. Market participants should learn from short selling activities, as short selling data are becoming more available, which could potentially speed up information transmission and improve market efficiency.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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ENDNOTES

[1] Boehmer et al. (2010) show that low short interest, in general, sends out positive signals about future stock returns. My study provides direct evidence of the source (e.g., anticipating corporate favourable news) of such positive signals.

[2] Short sales were reported on the 15th business day of each month before 2007 and increased to twice (the 15th and the last business day) per month after 2007. I keep only the monthly data for the 15th business day to maintain consistency.

[3] The breakpoints of size and BM portfolios are available from French's online data library: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[4] The BHAR(−1, +1) during the non-repurchase period is calculated based on the 15th business day of each non-repurchase month.

[5] The logic of using changes in analyst recommendations as a proxy follows Savor (2012), who argue that public news associated with new information is likely to be captured by analysts.

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